Process for drying of boats of wood and/or plastic materials

The invention relates to a process for drying of boats, with hulls consisting of wood and/or plastic materials, especially polyester materials.

It is recognized that water, especially salt water, causes the greatest part of all boat damage. Accordingly all boats after a certain interval of use in the elements have moisture damage to a more or less considerable degree such that inevitably it is necessary to immediately repair the damage to prevent total damage.

Moisture damage is caused by the following recurring factors: continuous cracking in the protective layers by deformations of the hull under the action of forces (for example wind and wave action, loading...), natural ageing of protective layers, impacts and friction by hard salt water and its waves at higher speeds, moisture penetration in the area of the assembly seams, water vapor diffusion damage in the interior...

Osmosis damage due to its frequency and the varying degree of its markedness (accidents or grounding) occupies a special position. Especially in case of damage with entry of water (accidents or grounding) serious consequent damage can quickly occur, such as swamping and the resulting osmosis formation in the boat shell, mildew, fungus, rot, cloud-like blistering, salt crystal formation with decomposition phenomena as a result of its volume expansion.

Accordingly it is important to quickly and effectively deliver active drying to the correspondingly affected boat hull. In any case the known and conventional drying processes are extremely expensive and tedious. Due to external effects of climate which cannot in general be predetermined (especially temperature and atmospheric humidity) drying generally lasts several

months (roughly 6 to 8 months) and in general cannot be defined beforehand in time. Moreover, the measurement technique used has a high error rate which is glossed over in favor of quality due to unnecessary added costs in boat treatment. The necessary consequences are non-material and financial losses of the yard customer, due to the longer interval of relinquishing his own boat and by foregoing necessary minor repairs (due to time and finances) which can lead in turn to subsequent damage.

Various publications, for example DE 195 44 889 A1, DE 94 13 736 U1, WO 92/08084 disclose the drying of buildings and/or solid components to remove moisture which has penetrated due to outside action or which is caused by construction using microwaves. In any case these publications do not contain any indications with respect to drying of essentially thin-walled boat hulls.

In consideration of the disadvantages of the prior art, the object of the invention is to devise a process for drying of boats, with hulls consisting of wood and plastic materials, especially polyester materials, a significant shortening of the drying process while largely avoiding external climatic effects and exact predetermination of the completion deadline being guaranteed, so that the guaranteed quality of the product, a reduction of repair obligations to a minimum, and thus a major cost reduction are possible.

As claimed in the invention, this object is achieved by the following process steps:

a. Cleaning of the boat shell outside and inside,

b. Damage analysis with measurement of the moisture and/or temperature of the material of the boat shell in spots or with blanket coverage in the initial state,

c. Removing a paint or other protective layer which may be present on the boat shell,

d. Attaching a reflection layer to the inside of the boat shell,

e. Computing the optimum drying process and drying of the boat hull by placing one or more microwave drying devices in the area of the boat shell to be dried, the boat shell being exactly localized and irradiated with microwave energy in doses,

f. Running measurement and monitoring of the temperature and moisture of the material and microwave radiation at the operating site of the microwave drying device during the drying process until material-specific residual moisture values are reached.

The process as claimed in the invention now enables extremely effective and much shorter implementation of the drying process. Here external climatic effects such as temperature and atmospheric humidity are largely precluded. When the commissioned yard accepts the boat, finished delivery after inspection and damage analysis based on use of scientifically sound measurement processes and new process technology can be mathematically exactly computed and thus can be scheduled exactly to the week. The work performed is transparently comprehensible to the customer. The repair obligations are reduced to the required minimum with guaranteed quality so that overall the time expenditure of 6-8 months in the past is reduced to a maximum 3 months.

With a considerable reduction of time expenditure at all explained levels (especially the lay days in drydock) and the quality of the product ensured at the same time, for the first time a yard is able to increase its productivity by several fold with minimum space requirement. This is associated with drastic cost reductions which can be passed on to the customers.

Previous losses of the customer of a non-material or financial type which resulted from a

long time interval of relinquishing his boat and which thus often induced the customer to forego necessary minor repairs (with the danger of the occurrence of major subsequent damage) have become immaterial with the use of the technology as claimed in the invention.

The drying technique used is based on use of microwave drying devices, the boat shell to be dried being irradiated exactly localized and defined with high frequency microwave energy. For this reason water molecules are set into vibration due to their electrical charge; this leads to heating. I.e., heat is formed specifically at the wet sites. The moisture can escape to the outside by a vapor pressure difference which builds up from the inside to the outside.

Advantageously the drying technique used requires only a solid base and is otherwise portable on an extremely small space so that hardware can be easily brought to the boat. It travels to the boat shell with the smallest, extremely low power consumption possible at the time, relative to the action. Interior drying is implemented by means of condensation drying. Due to its efficiency this conventional drying manner which was developed primarily in Northern Europe exclusively for interior drying has not lost importance.

The process as claimed in the invention can be advantageously supplemented by preventing or eliminating water saturation of parts or areas of the interior by advantageous measures such as removing the water by suction, ventilation and condensation drying especially in accident cases (water damage in the boat interior), before drying of the boat hull is carried out.

In one advantageous configuration the reflection layer consists of a self-adhesive, aluminum-coated plastic film which is applied to the inside of the boat shell. In this way microwaves penetrating to the inside are reflected and the ship's electronics are protected.

In another advantageous configuration of the invention the moisture and/or temperature of the material of the boat shell is measured at points or with blanket coverage, with or without contact. In this connection for example the kiln method in the processing of a sample of the material to be tested, spot video inspection, electrical conductivity measurement method, contactless infrapoint temperature measurement method, contactless radiation monitoring measurements and combined conductivity infrared measurements can be used.

Advantageously the microwave drying device consists essentially of a magnetron and an antenna, the high-frequency electromagnetic waves produced in the magnetron being emitted by a funnel-shaped antenna onto the boat shell. In this way irradiation of the boat shell exactly defined over area can be implemented. Advantageously the microwave power and/or the working frequency of the magnetron are constant or adjustable.

As desired, during the drying process relative motion between the microwave drying device and boat hull can furthermore be accomplished. Treatment for example of larger areas of moisture penetration or osmosis damage can be done more easily in this way.

Advantageously the operating time of the microwave drying devices depends on the completed damage analysis in time cycles, and the operating time should not exceed a boundary value per time cycle. This boundary value for the operating time is 10 minutes. After each cycle of operating time the temperature of the material of the boat shell is measured, its being ensured that it does not exceed a material-specific boundary value in order to avoid material-dependent damage to the boat shell. This boundary value for temperature is 60°C in boat shells of polyester materials. Here it can been found to be advantageous for the boat shell to be loaded with maximum

microwave radiation of 5 mW/cm^2.

In another advantageous configuration of the process the drying process is terminated at a residual moisture content of a maximum 5% moisture. After completion of the drying process of the boat hull it is sealed. Advantageously sealing takes place in a pressurized spraying process using epoxy resins, but also other suitable materials and processes can be used.

The delivery of the work performed after completion of the drying process takes place using a measurement record of all measured values so that transparent and objective evaluation of the what was done is possible to the advantage of all parties.

The invention is detailed below using one exemplary embodiment. The pertinent drawings show the following.

Figure 1 shows a partial cross section through a boat hull with microwave drying devices in use,

Figure 2 shows a top view according to arrow "A" in Figure 1.

In a drydock which is otherwise not detailed there is a sailboat with a hull 1 made of polyester material. The hull 1 (see Figures 1 and 2) has certain moisture damage (not illustrated) after longer use in salt water and is to be subjected to the drying process as claimed in the invention.

To do this, after docking, first the boat shell 2 is cleaned from the inside and outside. Then a detailed damage analysis is carried out since for example the water absorption capacity of different materials is different. Using highly sensitive measurement processes and devices the degree of moisture penetration and areas of osmosis damage are determined and analyzed. In this connection the moisture and if necessary the temperature of the material of the boat shell 2 are determined in

spots or over an area and are documented.

In the evaluation of the damage analysis, first the protective paint layer on the boat shell 2 is removed, for example, using a manual process. Furthermore, on the inside of the boat shell 2 a reflection layer 3 consisting of aluminum-coated plastic film is cemented. Generally the ship's compass must be separately lined.

In the evaluation of damage analysis, furthermore the optimum drying process (microwave power, working frequency, time cycles, and duration of operation, necessary measurements, material-specific boundary values...) are computed. After completion of special protective measures, such as blocking with protective walls impermeable to microwaves and identification of the working and radiation area, and turning off the ship's electronics, microwave drying devices 4 are moved into the prescribed position to the boat shell 2 which is to be dried using adjusting and fixing devices 5. To do this, the microwave drying devices 4 can be pivoted transversely to the cross section of the boat hull 1 (see Figure 1) (arrow B) and/or pushed on rollers (arrow C) or adjusted vertically (arrow D). In addition, they can be pushed parallel to the lengthwise axis of the boat hull 1 (see Figure 2) on rollers (arrow E).

The microwave drying devices 4, in addition to the control and chopper-type power supply unit and the corresponding cabling (not shown), consist of a magnetron (not shown) and an antenna 6. In the magnetron, high frequency electromagnetic waves are produced which are emitted by the antenna 6 in the known manner. To do this, the antenna 5 advantageously has a funnel shape so that the radiation can be trained directly onto the boat shell 2 in its extension.

After completion of the corresponding preparation activities, by turning on the microwave

drying devices 4 the drying process is started. In doing so, the boat shell 2 to be dried is exactly located and irradiated with doses of microwave energy, so that based on the vapor pressure drop which builds up, the moisture in the material can escape to the outside. This process is amplified by reflection of microwaves on the reflection layer 3. The drying process is continuously monitored using multimedia with consideration of all process parameters. In particular the length of operation of the microwave drying devices 4 must be exactly maintained according to the prescribed time cycles, the maximum operating time being 10 minutes. Moreover after each time cycle the temperature of the material of the boat shell 2 can be measured, and it must be ensured that material-specific boundary values are not exceeded. For boat shells 2 of polyester materials, this boundary value is 60°C, since polyester materials begin to decompose at 70°C. In addition, the material moisture content and microwave radiation are measured.

Alternately, during the drying process relative motion between the microwave drying devices 4 and the boat hull 1 can be carried out, when for example larger area moisture penetration and osmosis damage are to be treated. To do this, the adjusting and fixing devices 5 are displaced transversely and/or lengthwise to the lengthwise axis of the boat hull 1 according to the arrows B, C, D, E, depending on the requirement.

When residual moisture content values of a maximum 5% moisture are measured, the drying process can be ended at the treatment site. At this point, depending on the damage case, the entire drying process can be ended, or using the adjusting and fixing devices 5 a new (treatment) position of the microwave drying devices 4 to the outside boat shell 2 can be set and further monitored and a continuing monitored and controlled drying process can be initiated/carried out.

After completion of the (entire) drying process, a measurement record of all process-relevant parameters is prepared and documented. The hull 1 is preferably sealed using epoxy resins in a pressurized spraying process or according to another suitable process.

One version of the process as claimed in the invention is used in case of sea water damage (water damage inside the boat) such that before the above explained drying of the hull 1, to minimize the damage first by immediate removal of water by suction, by opening all inside hatches and linings, and setting up condensation driers which are matched to the inside volume of the hull 1, the inside is dried as much as possible before water saturation of the materials/parts, since a correspondingly higher interior moisture greatly influences the drying process as claimed in the invention with respect to time required.

The invention is not limited by the details of the above described exemplary embodiments. In particular, advantageous variation of the sequence of process steps b, c, d is possible.

Reference number list

1	hull
2	boat shell
3	reflection layer
4	microwave drying device
5	adjusting and fixing device
6	antenna

Arrow A	direction of viewing
Arrow B	direction of movement/displacement
Arrow C	direction of movement/displacement
Arrow D	direction of movement/displacement
Arrow E	direction of movement/displacement